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Title: Overview of Java-based Nuclear Information Software (JANIS)

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Overview of Java-based Nuclear Information Software (JANIS)

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MCNP Team Meeting
March 10, 2022

Outline

Introduction & Motivation

Getting & Configuring JANIS

Data Queries

Interaction Cross Sections

Covariances via Correlation Matrix

Fission Yields

Radioactive Decay

Data Manipulations & Comparisons

Weighting (Multi-group Collapse)

Querying Multiple Libraries

Evaluation vs. Experiment

Introduction & Motivation

Objective: overview of JANIS software and select features

- ▶ JANIS: Java-based Nuclear Information Software [1]
- ▶ Available for offline (Java-based) and online (website-based) use
 - ▶ Focus of this talk is on the offline application
 - ▶ Both approaches are cross platform
- ▶ Visualize and manipulate a variety of nuclear data
 - ▶ Decay & fission-yield data
 - ▶ Interaction data: cross-sections, distributions, uncertainties
- ▶ Access a variety of libraries: EN(S)DF, JEFF, JENDL, TENDL, IRDF, etc.
- ▶ Why this talk?
 - ▶ JANIS is cited in several MCNP classes
 - ▶ Despite usefulness, awareness of JANIS is not pervasive
 - ▶ Alternative to [BNL NNDC](#), [KAERI NDC](#), [IAEA EXFOR](#), etc.

Getting & Configuring JANIS

The screenshot shows the NEA (Nuclear Energy Agency) website for the JANIS project. The main content is a large periodic table of elements, version Janis-2019, with various isotopes highlighted in different colors. To the right, there's a sidebar titled "Related topics" with links to "Nuclear Data Services" and "Nuclear data". Below the table, there's a "JANIS screenshots" section with a red box around the first item, "#1 Launch JANIS 4.1 Java Web Start". A red arrow points from this box down to the "Downloads" section at the bottom left, which includes links for "Software, Manual, DVD 4.0 ISO" and "JANIS Books". The top navigation bar includes links for "ABOUT US", "TOPICS", "NEWS AND RESOURCES", "LEARNING AND TOOLS", "DATA BANK", and "MY NEA". The URL in the address bar is https://www.oecd-nea.org/jcms/pl_39910/janis.

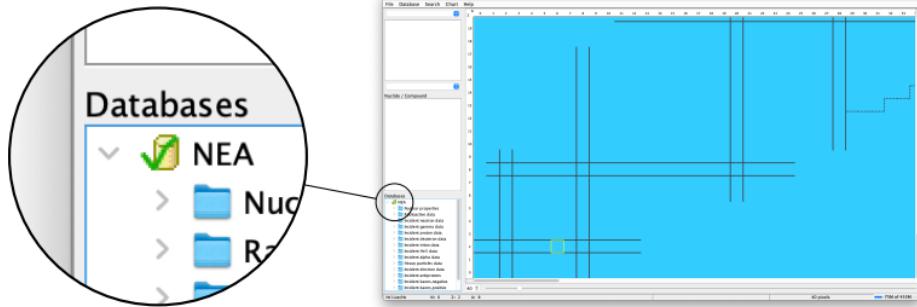
Available from: https://www.oecd-nea.org/jcms/pl_39910/janis.

Access downloads; choose "Software Only."

Note: a Google search for "janis" first gives Janis Joplin hits; suggest searching for "janis oecd".

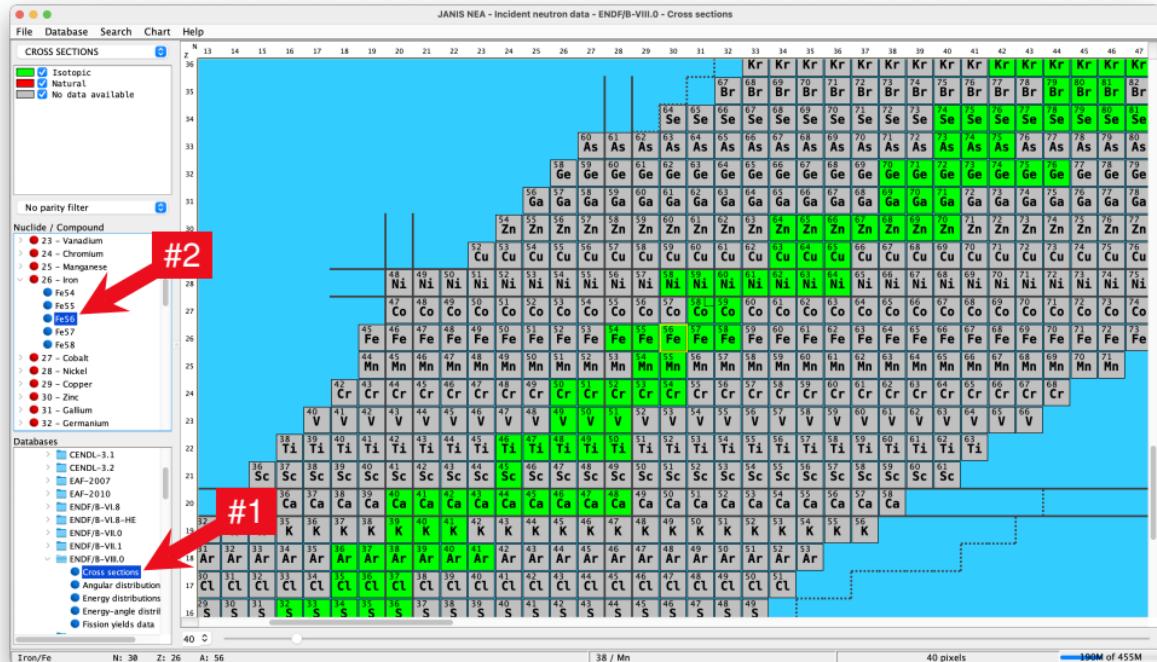
Getting & Configuring JANIS, cont.

- ▶ Extract the ZIP file
 - MAC Bundle has caused problems recently with direct execution
 - ▶ Navigate to extraction directory and execute janis.sh
 - ▶ Effectively: `java -Xms100M -Xmx512M -jar software/Janis.jar`
 - Linux Untested, but is expected to be the same as macOS
 - Windows Navigate to extraction directory and execute janis.bat
-
- ▶ Once launched, may need to set proxy via File menu Preferences dialog
 - ▶ Use Network tab and Test Connectivity button

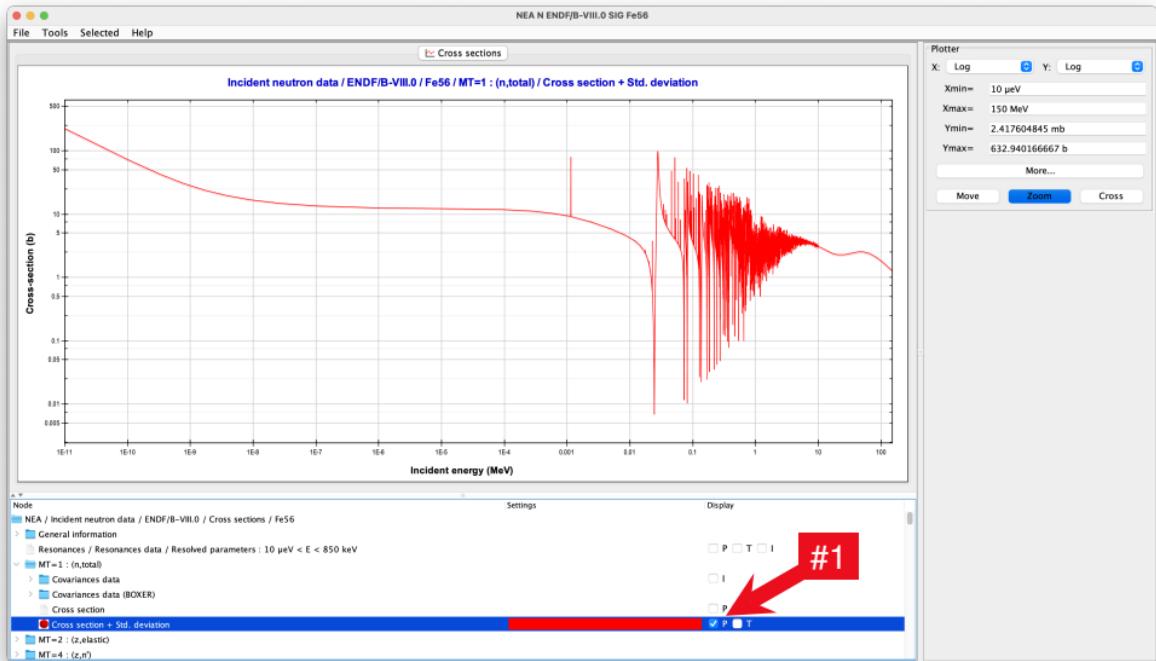


Look for the green checkmark—if present, one can proceed.

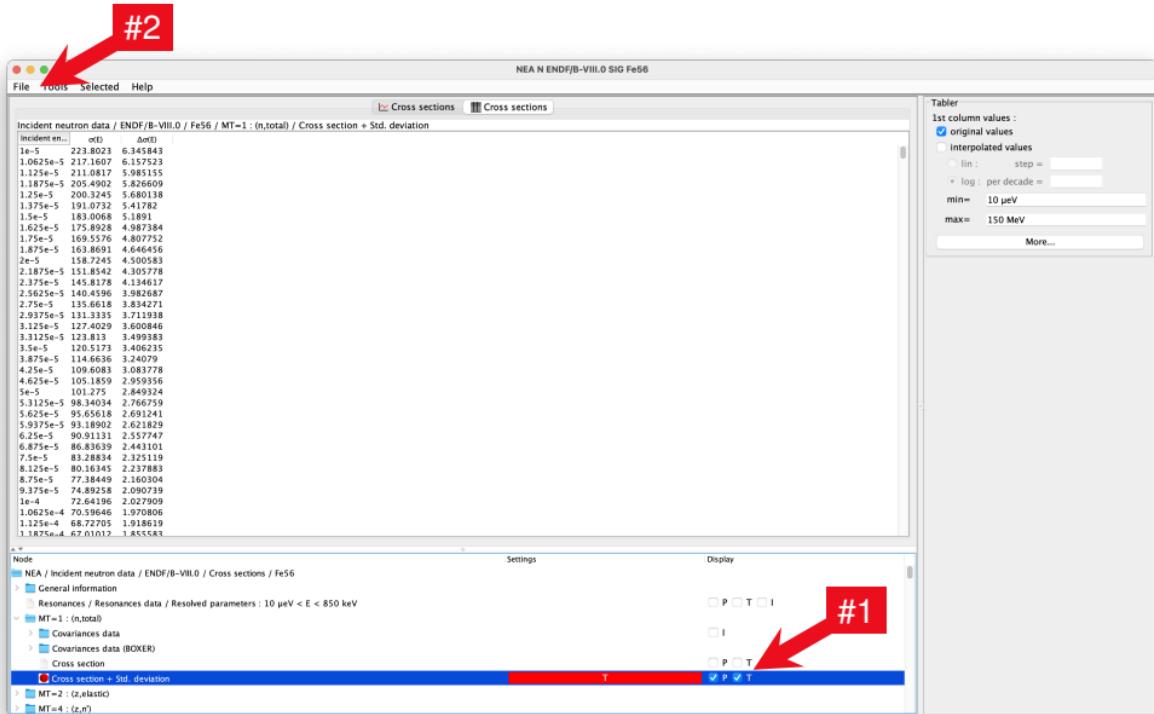
Interaction Cross Sections: Total Fe-56 + Unc.



Interaction Cross Sections: Total Fe-56 + Unc., cont.



Interaction Cross Sections: Total Fe-56 + Unc., cont.



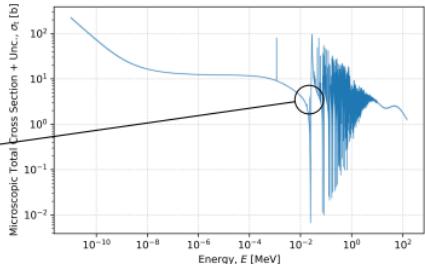
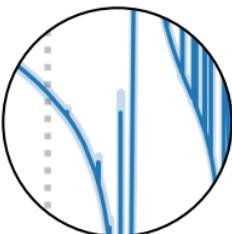
Plotting the Exported CSV via NumPy

```
#!/usr/bin/env python
```

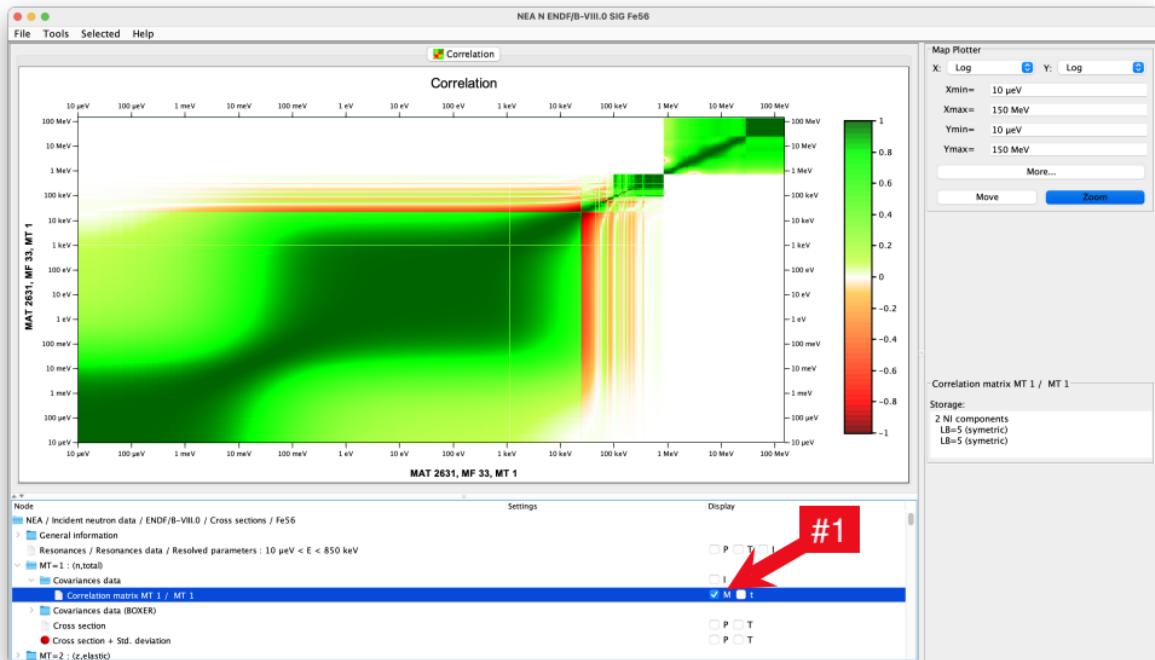
```
import matplotlib.pyplot as plt
import numpy as np

x, y, e = np.loadtxt("fe56_mt1_xs_stdev.csv", skiprows=3, delimiter=";", unpack=True)

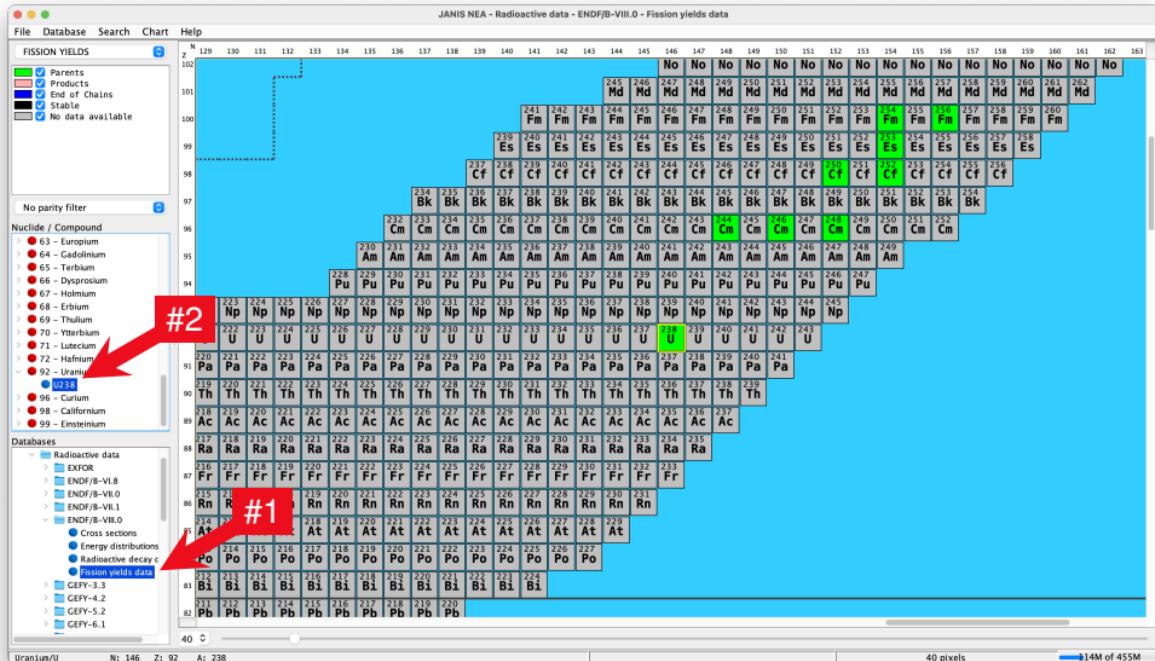
fig, ax = plt.subplots(figsize=(6.5, 6.5 / 1.62))
x /= 1e6
p = plt.plot(x, y, lw=0.5)
plt.fill_between(x, y - e, y + e, alpha=0.25, color=p[-1].get_color())
plt.xscale("log")
plt.yscale("log")
plt.xlabel("Energy, $E$ [MeV]")
plt.ylabel(r"Microscopic Total Cross Section + Unc., $\sigma_{\mathrm{t}}$ [b]")
plt.grid(ls=":", color="#000000", alpha=0.25)
plt.savefig("fe56_mt1_xs_stdev.png", dpi=600, bbox_inches="tight")
```



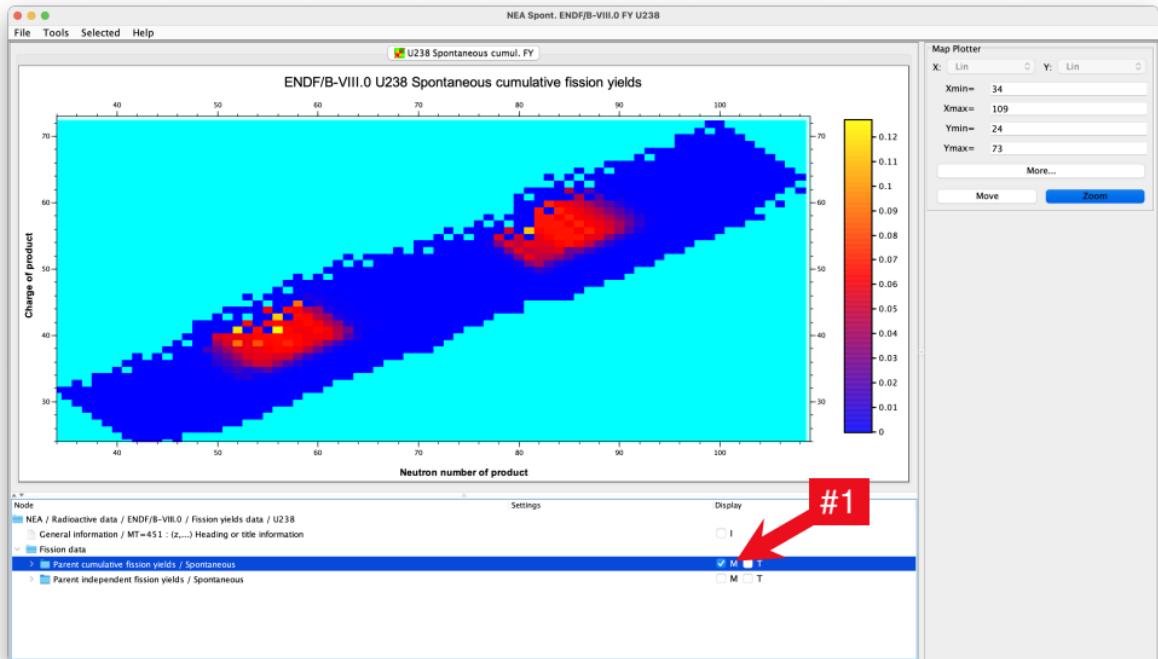
Covariances via Correlation Matrix



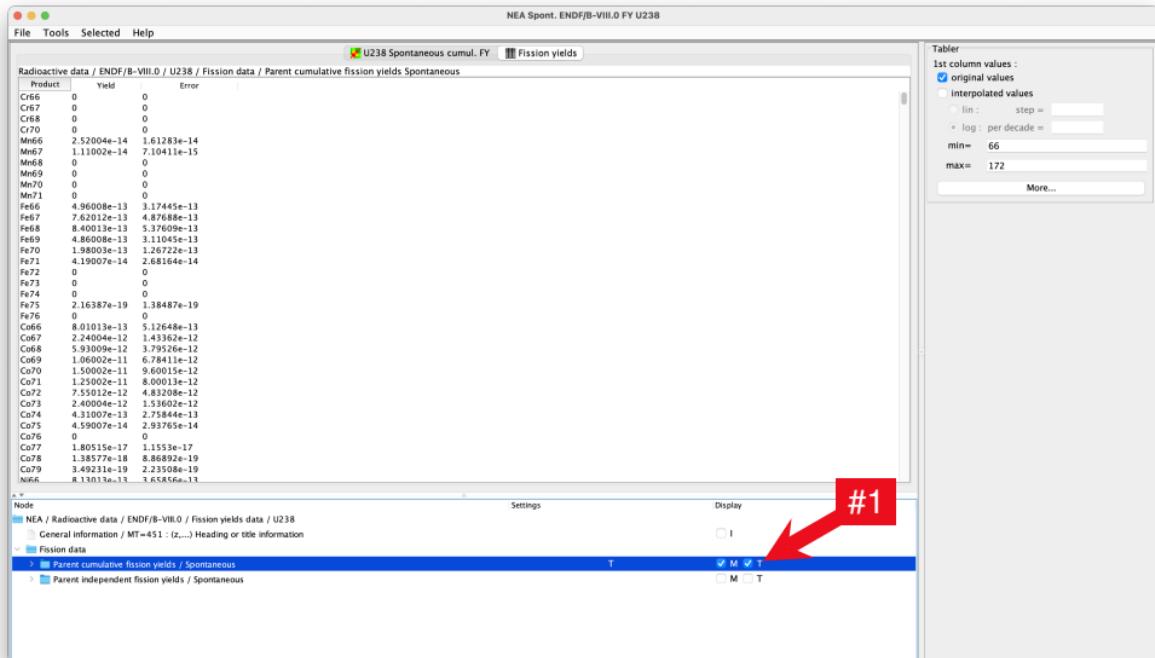
Fission Yields



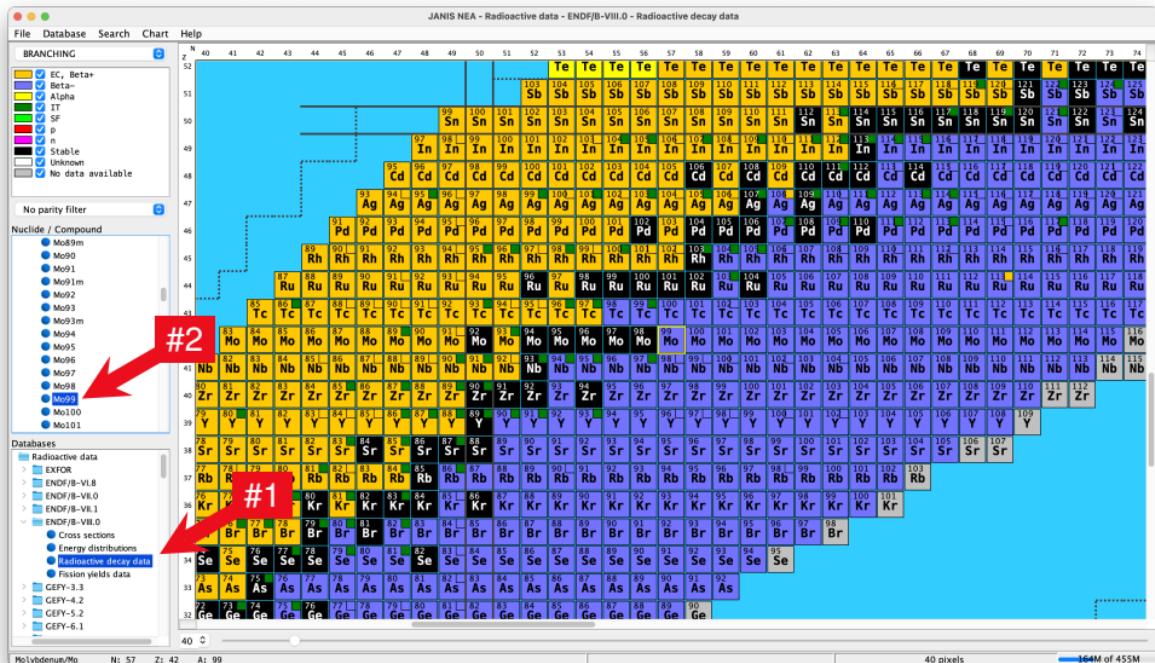
Fission Yields, cont.



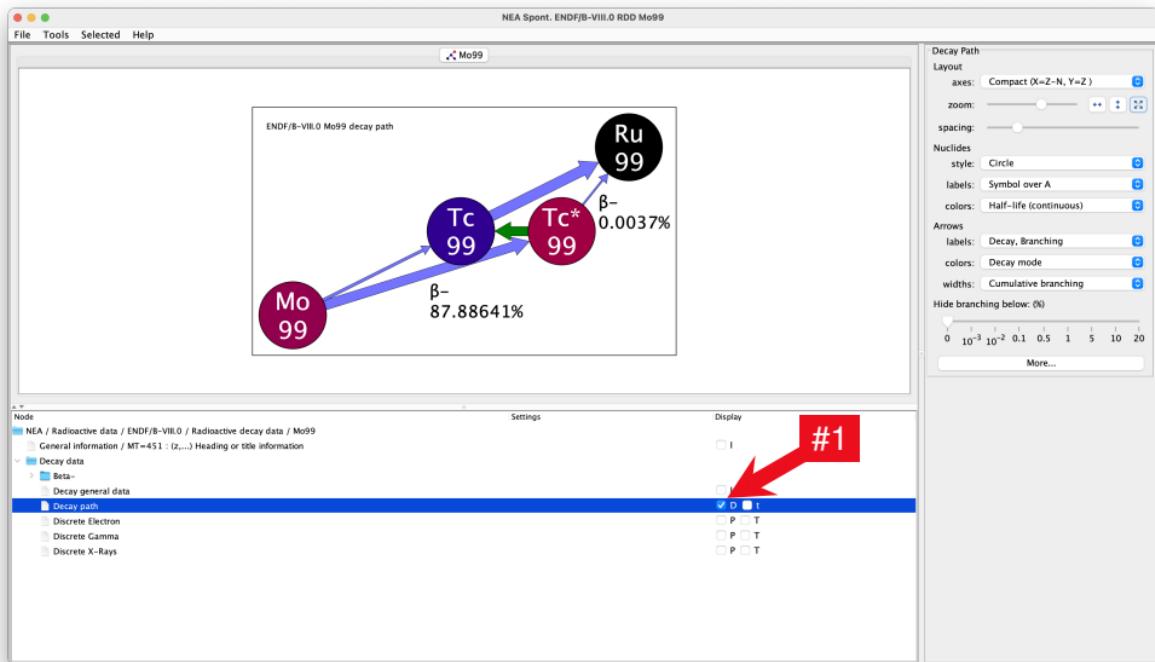
Fission Yields, cont.



Radioactive Decay



Radioactive Decay, cont.



Radioactive Decay, cont.

NEA Spont. ENDF/B-VIII.0 RDD Mo99

File Tools Selected Help

Mo99 Mo99 decay path

Radioactive data / ENDF/B-VIII.0 / Mo99 / Decay data / Decay path

#	Parent	Product	Half-Life	Half-Life error	Branching	Branching error	Decay mode
0	Mo99	Tc99m	237513.6 s	86.40000 s	87.88641 %	0.2302841 %	Beta-
1	Mo99	Tc99	237513.6 s	86.40000 s	12.11359 %	0.2302841 %	Beta-
2	Tc99m	Tc99	21624.12 s	1.800000 s	99.9963 %	0.0006 %	Isomeric transition
3	Tc99m	Ru99	21624.12 s	1.800000 s	0.0037 %	0.0006 %	Beta-
4	Tc99	Ru99	6.66181E+12 s	3.786912E+10 s	100 %		Beta-

Note: NDA / Radioactive data / ENDF/B-VIII.0 / Radioactive decay data / Mo99
General information / MT=451 : (z,...) Heading or title information

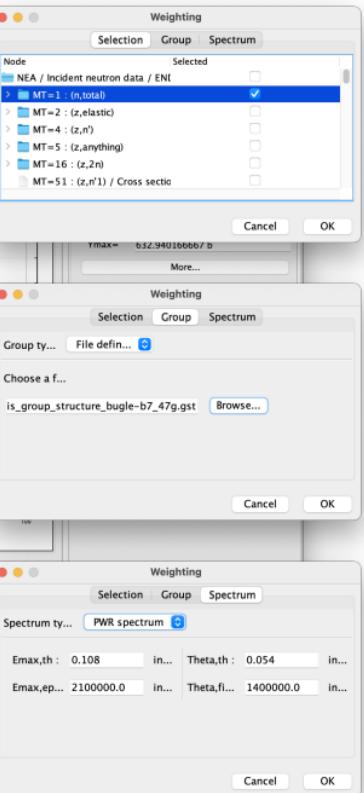
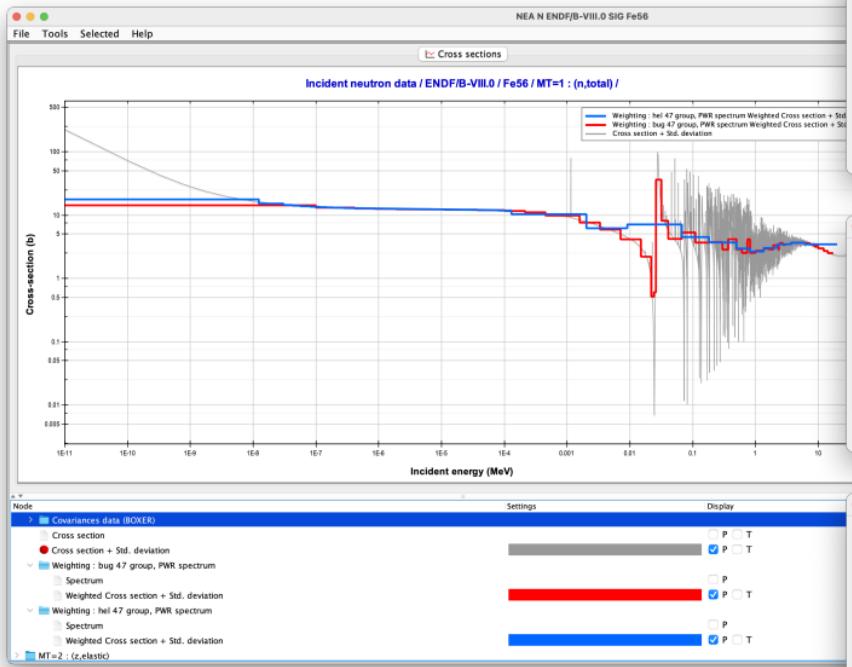
Decay data
Beta-
Decay general data
Decay path
Discrete Electron
Discrete Gamma
Discrete X-Rays

Settings Display

I D t
 I P T
 P T

#1

“Weighting”: BUGLE-B7 vs. HELIOS [4, 5]



Querying Multiple Libraries

The screenshot shows the ENDF search interface with several red arrows numbered 1 through 6 pointing to specific fields and results.

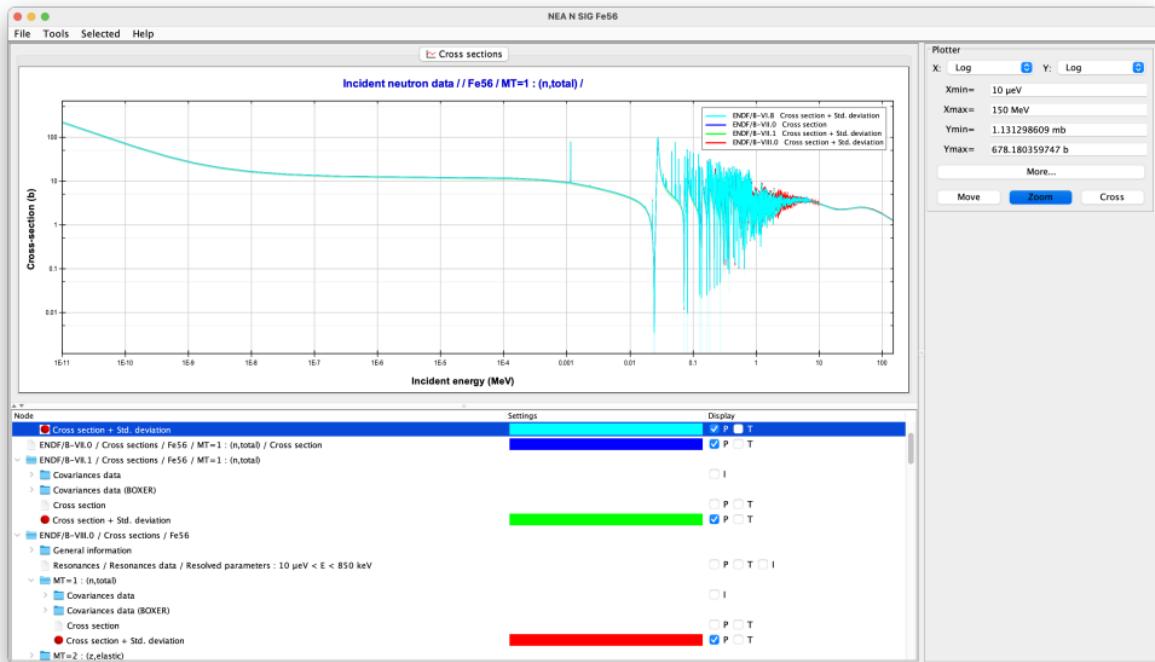
- #1: Incident particle dropdown menu, showing "Incident neutron data" selected.
- #2: Library dropdown menu, showing "Any library" selected.
- #3: Material input field, showing "Z: 26 (Fe) Iron".
- #4: State input field, showing "State :".
- #5: The main search results table, which lists various ENDF libraries and their properties for Fe-56. One row is highlighted with a blue background: "NEA Incident neutron data ENDF/B-VI.8 Fe56 3 MT=1 : (n,total)".
- #6: A group of buttons on the right: "Search", "Open results", "Save results", "Print", "Reset", and "Close".

History :
Results
60 rows

Search	Incident particle	Evaluation	Material	MF	MT
NEA	Incident neutron data	BROND-2.2	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	BROND-3.1	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	BROND-3.2	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	CENDL-2.1	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	CENDL-3.1	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	CENDL-3.2	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	EAF-2007	Fe56		
NEA	Incident neutron data	EAF-2010	Fe56		
NEA	Incident neutron data	ENDF/B-VI.8	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VI.8	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VI.8-HE	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VII.0	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VII.1	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VII.1	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VIII.0	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	ENDF/B-VIII.0	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	FENDL-2.1	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	FENDL-2.1	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	FENDL-3.1b	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	FENDL-3.1b	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-2.2	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.0	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.0	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.1	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.1	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.1.1	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.1.1	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.1.2	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.1.2	Fe56	33	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.2	Fe56	3	MT=1 : (n,total)
NEA	Incident neutron data	JEFF-3.2	Fe56	33	MT=1 : (n,total)

Ready

Querying Multiple Libraries, cont.



Evaluation vs. Experiment

The screenshot shows the EXFOR search interface with several numbered annotations:

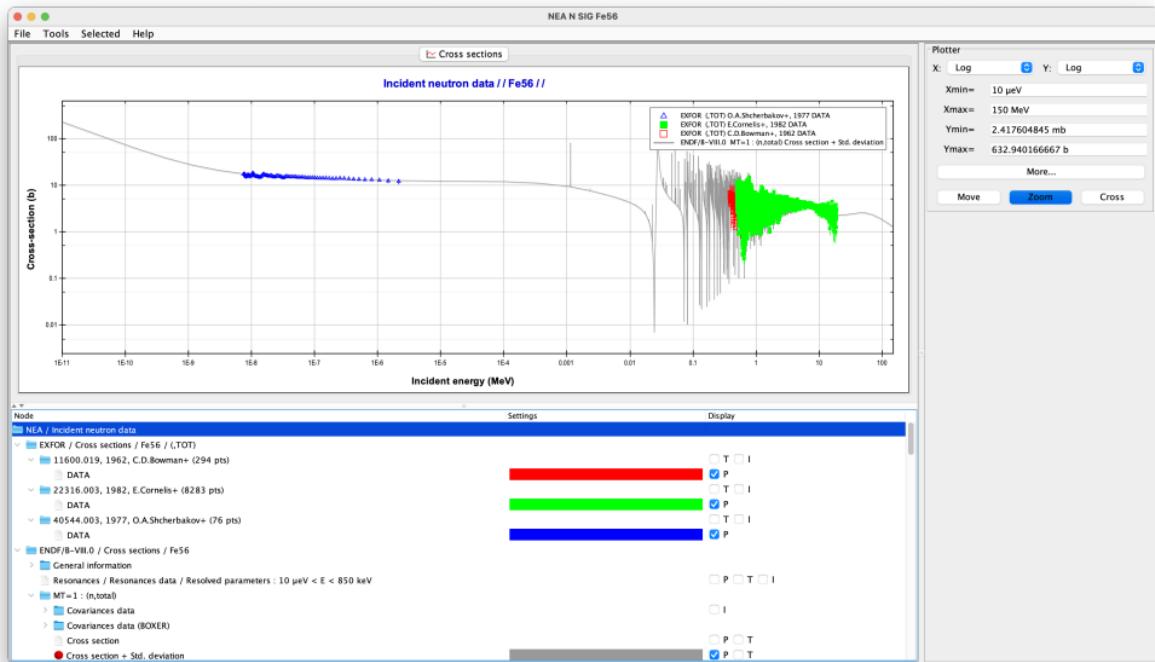
- #1: A red arrow points to the "Target" field where "Z : 26 (Fe) Iron" is entered.
- #2: A red arrow points to the "Search" button in the top right corner.
- #3: A red arrow points to the "Maximize" button in the bottom right corner.
- #4: A red arrow points to the "Main ref." button in the top right corner.

The search results table displays the following data:

Search	Subentry	Target	Product	Reaction	Q	Q	#pts	E min	E max	Author(s)	Title	Institute
NEA	[1]1600.018	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	294	[91.00 keV]	[657.00 keV]	C.D.Brown+ J.A.Morrell+	S- AND P-WAVE NEUTRON SPECTROSCOPY, PART VIII, SUBSH...	1USADKE
NEA	[1]1719.003.4	Fe56	-	[26-Fe-56(N,TOT),SIG,RES]	CS	SIG,RES	1				NEUTRON CAPTURE IN IRON,	1USABNL
NEA	[2]2216.003	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	8283	[500.05 keV]	[18.985 MeV]	E.Cornell+	[TOTAL NEUTRON CROSS SECTION OF FE-54 AND FE-56 IN T...	1LZZCFL
NEA	40075.006.1	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.1	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.1	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.1	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.1	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.2	Fe56	-	[26-Fe-56(N,TOT),SIG,SPA]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.2	Fe56	-	[26-Fe-56(N,TOT),SIG,SPA]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.2	Fe56	-	[26-Fe-56(N,TOT),SIG,SPA]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40075.006.2	Fe56	-	[26-Fe-56(N,TOT),SIG,SPA]	CS	SIG	11.8	MeV	1.8 MeV	V.M.Morozov+	Two mechanisms of elastic scattering in nuclear opti...	4RUSKUR
NEA	40544.003	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	767.50	meV	2.17 eV	O.A.Scherbakov	SLOW NEUTRON TOTAL AND RADATIVE CAPTURE CROSS- SECT...	4RUSFEI
NEA	[4]0544.003	Fe56	-	[26-Fe-56(N,TOT),SIG]	CS	SIG	767.50	meV	2.17 eV	O.A.Scherbakov+	[SLOW NEUTRON TOTAL AND RADATIVE CAPTURE CROSS- SECT...	4RUSFEI
NEA	40556.004.3	Fe56	-	[26-Fe-56(N,TOT),SIG,RES]	CS	SIG,RES	1			V.N.Vinogradov+	Measurement of the total neutron cross sections of t...	4RUSFEI

Ready

Evaluation vs. Experiment, cont.



Questions?

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Covariances via Correlation Matrix
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Data Manipulations & Comparisons
Weighting (Multi-group Collapse)
Querying Multiple Libraries
Evaluation vs. Experiment

Contact Information

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jkulesza@lanl.gov

Backup Slides

References

- [1] N. Soppera, M. Bossant, and E. Dupont, "JANIS 4: An Improved Version of the NEA Java-based Nuclear Data Information System," *Nuclear Data Sheets*, vol. 120, pp. 294–296, June 2014.
- [2] M. E. Rising, "Evaluating Sensitivity-based Similarity Metrics Between Applications and Benchmarks," Tech. Rep. LA-UR-19-29241, Los Alamos National Laboratory, Los Alamos, NM, USA, Sept. 2019.
- [3] N. Soppera, T. Ergun, M. Kellett, A. Nouri, Y. Rugama, H. Henriksson, and E. Dupont, "JANIS 4.0 User's Guide," Oct. 2013. Rev. 1.
- [4] J. M. Risner, D. Wiarda, M. E. Dunn, T. M. Miller, D. E. Peplow, and B. W. Patton, "Production and Testing of the VITAMIN-B7 Fine-Group and BUGLE-B7 Broad-Group Coupled Neutron/Gamma Cross-Section Libraries Derived from ENDF/B-VII.0 Nuclear Data," Tech. Rep. NUREG/CR-7045 (ORNL/TM-2011/12), Oak Ridge National Laboratory, Oak Ridge, TN, USA, Jan. 2011.

References

- [5] J. J. Casal, R. J. J. Stamm'ler, E. Villarino, and A. Ferri, "HELIOS: Geometric Capabilities of a New Fuel Assembly Program," in *Proceedings of the International Topical Meeting on Advances in Mathematics, Computations, and Reactor Physics*, (Pittsburgh, PA, USA), pp. 10.2–1–1 to 10.2–1–13, American Nuclear Society, 1991.

JANIS Group Structure File: BUGLE-B7 [4]

neutron group structure.....bug	47	group	24	2.9721E+05	3.6883E+05
47	1.0000E-05	1.0000E-01	23	3.6883E+05	4.9787E+05
46	1.0000E-01	4.1399E-01	22	4.9787E+05	6.0810E+05
45	4.1399E-01	8.7643E-01	21	6.0810E+05	7.4274E+05
44	8.7643E-01	1.8554E+00	20	7.4274E+05	8.2085E+05
43	1.8554E+00	5.0435E+00	19	8.2085E+05	1.0026E+06
42	5.0435E+00	1.0677E+01	18	1.0026E+06	1.3534E+06
41	1.0677E+01	3.7267E+01	17	1.3534E+06	1.6530E+06
40	3.7267E+01	1.0130E+02	16	1.6530E+06	1.9205E+06
39	1.0130E+02	2.1445E+02	15	1.9205E+06	2.2313E+06
38	2.1445E+02	4.5400E+02	14	2.2313E+06	2.3457E+06
37	4.5400E+02	1.5846E+03	13	2.3457E+06	2.3652E+06
36	1.5846E+03	3.3546E+03	12	2.3652E+06	2.4660E+06
35	3.3546E+03	7.1017E+03	11	2.4660E+06	2.7253E+06
34	7.1017E+03	1.5034E+04	10	2.7253E+06	3.0119E+06
33	1.5034E+04	2.1875E+04	9	3.0119E+06	3.6788E+06
32	2.1875E+04	2.4176E+04	8	3.6788E+06	4.9658E+06
31	2.4176E+04	2.6058E+04	7	4.9658E+06	6.0653E+06
30	2.6058E+04	3.1828E+04	6	6.0653E+06	7.4082E+06
29	3.1828E+04	4.0868E+04	5	7.4082E+06	8.6071E+06
28	4.0868E+04	6.7379E+04	4	8.6071E+06	1.0000E+07
27	6.7379E+04	1.1109E+05	3	1.0000E+07	1.2214E+07
26	1.1109E+05	1.8316E+05	2	1.2214E+07	1.4191E+07
25	1.8316E+05	2.9721E+05	1	1.4191E+07	1.7332E+07

JANIS Group Structure File: HELIOS [5]

neutron group structure.....hel 47 group

47 0.000000E+00 1.239596E-02

46 1.239596E-02 3.061288E-02

45 3.061288E-02 4.275520E-02

44 4.275520E-02 5.692194E-02

43 5.692194E-02 8.196816E-02

42 8.196816E-02 1.115699E-01

41 1.115699E-01 1.457206E-01

40 1.457206E-01 1.844302E-01

39 1.844302E-01 2.705213E-01

38 2.705213E-01 3.576701E-01

37 3.576701E-01 5.032318E-01

36 5.032318E-01 6.250621E-01

35 6.250621E-01 7.820830E-01

34 7.820830E-01 9.099967E-01

33 9.099967E-01 9.710043E-01

32 9.710043E-01 1.013699E+00

31 1.013699E+00 1.072203E+00

30 1.072203E+00 1.125397E+00

29 1.125397E+00 1.166404E+00

28 1.166404E+00 1.235105E+00

27 1.235105E+00 1.457402E+00

26 1.457402E+00 1.855391E+00

25 1.855391E+00 2.382393E+00

24 2.382393E+00 3.927903E+00

23 3.927903E+00 4.450897E+00

22 4.450897E+00 5.043477E+00

21 5.043477E+00 5.715008E+00

20 5.715008E+00 6.476017E+00

19 6.476017E+00 7.338215E+00

18 7.338215E+00 8.315287E+00

17 8.315287E+00 1.209903E+01

16 1.209903E+01 1.371000E+01

15 1.371000E+01 2.902291E+01

14 2.902291E+01 4.785117E+01

13 4.785117E+01 7.889325E+01

12 7.889325E+01 1.300704E+02

11 1.300704E+02 2.034700E+03

10 2.034700E+03 9.118801E+03

9 9.118801E+03 6.737900E+04

8 6.737900E+04 1.831601E+05

7 1.831601E+05 4.978702E+05

6 4.978702E+05 8.208500E+05

5 8.208500E+05 1.353400E+06

4 1.353400E+06 2.231299E+06

3 2.231299E+06 3.678800E+06

2 3.678800E+06 6.065300E+06

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